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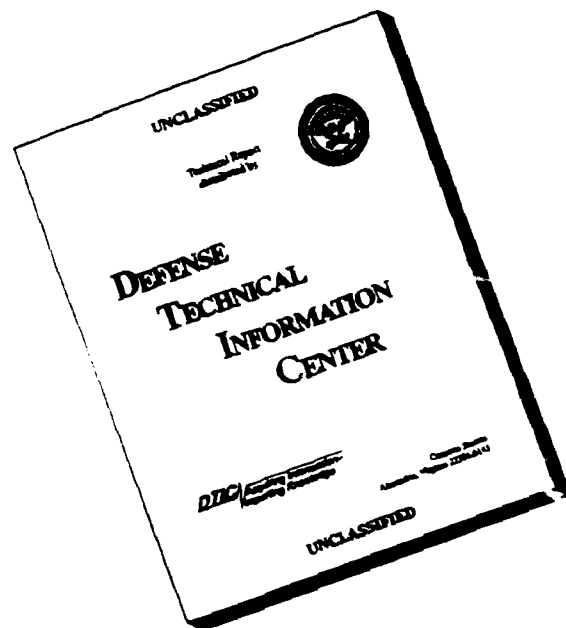
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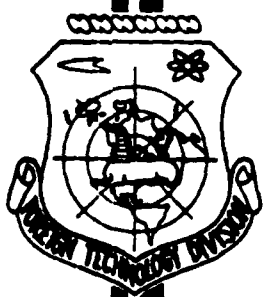
TRANSLATION

COMBINED EFFECT OF VIBRATION AND NOISE
ON THE HUMAN ORGANISM

By

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FOREIGN TECHNOLOGY DIVISION



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Combined Effect of Vibration and Noise on
the Human Organism

by

A. A. Arkad'yevskiy

In recent years we investigated the effect of different frequency noise with an intensity of from 70 to 100 db on the human organism, whereby we have determined the noise parameters, when the magnitude of physiological displacements in the audio analyzer, subcortical and vegetative branches of the central nervous system appears to be insignificant, and the restoration of basic reactions occurs within 1-2 min. Such a displacement was obtained after the effect of a low frequency noise with an intensity of 85-95 db, medium frequency noise with an intensity of 80-85 db and high frequency noise with an intensity of 70-80 db (A.A. Arkadyevskiy 1960, 1962).

Investigated were also the parameters of harmless effect of general vertical vibration on the human organism. It was found, that a general vibration with a frequency of 30, 40 and 50 c and amplitude of 15 microns causes no noticeable displacements in the subcortical branch of the central nervous system. Vegetative reaction also do not go beyond the limits of normal deviations. The slight displacement of physiological reactions is observed also after the effect of general vibration with a frequency of 75 c and amplitude of 10 microns (G.I. Ruzantsev, 1960).

These data were obtained in conditions of isolated, individual effect of noise and general vibration on the organism during laboratory investigations. It is known, that in industry these factors affect together with different combinations between each other, as well as by other factors of industrial medium. The study of the combined effect is important for hygienic standardization of industrial factors.

In literature sources we have found no data, which could characterize the simultaneous effect of noise and general vibration of standard levels. The few reports, written on this subject, speak about a more intensive effect of a noise/vibration combination on the human organism. In the report by A.G.Rakhmilevich (1960) is offered a conclusion, that industrial vibration may cause a peculiar change in the cochlea which promotes first of all a reduction in perception of lower sounds through the air and through the bone as well. Furthermore, such vibration may intensify the effect of industrial noise, as result of which there is a more expressed reduction in aural sensitivity in the zone of perception of low level tones, characteristic for the effect of vibration, the harmful effect of which intensifies with the rise in its frequency. In his second report A.G.Rakhmilevich, investigating professional hearing difficulties among workers exposed to the combined effect of noise and vibration, discovered among them a much higher degree of hearing difficulty as compared with persons which are exposed to the effect of the noise factor only.

In our lab was investigated the effect of "pure" medium frequency noise with an intensity of 80 db and its combined action with general vertical vibration with a frequency of 20 c and amplitude of 50 microns (L.I.Makrirova). The author of the investigation revealed, that at the additional effect of general vibration there is a noticeable increase in the effect of noise on the aural sensitivity, stability of body equilibrium deteriorates, the coordinating role of the organ of vision in the function of a person's state decreases, excitability of cortex cerebri rises and the stability of the cardio-vascular system decreases. These investigations are of considerable scientific interest, but on their basis is impossible to obtain a value, defining the permissible levels, because the noise and vibration parameters, taken by the authors of the mentioned investigations, exceed the standard ones. The task of this experiment was to investigate the combined action of medium frequency noise with an intensity of 85 db and general vibration with a frequency of 50 c and amplitude of 15 microns, i.e. the basis of the investigation was the simultaneous effect of noise

and vibration, the individual effect of which is reflected in a slight dynamic displacement of physiological reactions of the organism.

The observations were conducted in a sound proof chamber, equipped with vibrator O,2VS-70. Noise and vibration of experimental parameters were fed into the chamber: the first one from a tape recorder, the second from a vibrator. The noise of the vibrator was "reduced" by antiphones. The duration of the effect of irritants was one hour.

Subjected to observation were five healthy young people between the ages of 19 and 24 years, with normal hearing. Four series of observations were made for the purpose of evaluating: 1) effect of lab conditions without irritation by noise and vibration; 2) effect of "pure" noise; 3) effect of "pure" vibration; 4-combined effect of vibration and noise.

The investigation methods - audiometry, chronoflexometry and ECG.

The state of organismal functions ^{was} determined prior to the effect of irritants, immediately after their effect and within definite time intervals for a period of 30 min.

Measurement of values of reactive displacements, obtained without irritation by mentioned factors, did not allow to detect noticeable changes in functions under experimental conditions. The state of the very same functions after irritation with "pure" factors individually represents a picture of slight dynamic displacements with rapid restoration of initial reactions within 1 - 1.5 min.

As stated above, in the completed series of investigations the job was to study the combined effect of noise and general vibration. The reactive displacement is here noticeably different from the displacement during individual action of the factor, by magnitude and nature of the restoration activity of the organism.

The first three pairs of curves (fig.1) do not differ by an expressed displacement in aural sensitivity. At the same time the combined action of noise and general vib-

tion is reflected in the displacement of aural sensitivity in direction of an 8-10 db reduction and delay in restoration of initial values by 3 minutes, and in individual cases even more.

A shift in time of latent period of visual motorial reaction without irritation, as well as after individual irritation by noise and vibration varied within 5-10 δ in direction of extension or curtailment of this type. Combined action of these factors is reflected in extension of reaction time by 16-25 δ . Restoration of initial values takes place at the third and only in individual cases - at the fifth minute.

It is evident from fig.2. that the relative number of cases with extended latent reaction time after individual irritation by noise and vibration exceeds somewhat the number of cases of analogous value among the very same observed ones after they have been exposed to experimental conditions without the effect of the mentioned factors. During simultaneous effect of these factors the instances with extended latent reaction time reach 100%.

On the ECG we have not observed to have not observed a displacement in myocardial potentials after individual action of medium frequency noise with an intensity of 85 db and general vibration with a frequency of 50 c and amplitude of 15 μ .

But the combined effect of these factors in mentioned parameters was reflected in the extension of the diastolic phases of the heart, frequenting of pulse and reduction in systolic characteristic.

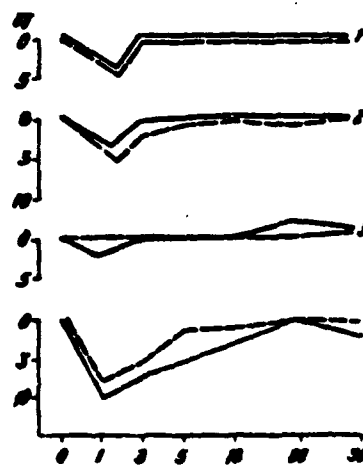


Fig.1. Displacement of aural sensitivity after combined effect of general vibration and noise. Dotted curves - aural sensitivity at a frequency of audio signal 200 c; solid curves - aural sensitivity on a frequency of audio signal 2000 c. 1 - without irritation by factors; 2 - after noise irritation; 3 - after irritating by general vibration; 4 - after irritation by noise and vibration.

In one of the ECG, typical for persons observed by us, the basic intervals in II were derived immediately after discontinuation of noise and within 5 minutes after the effect they constituted: PQ - 0.16 - 0.17 sec; QT - 0.33 - 0.34 sec; TP - 0.48 - 0.5 sec. The very same picture was obtained in experiments with the application in role of irritant a general vibration with a frequency of 50 c and amplitude of 15 μ .

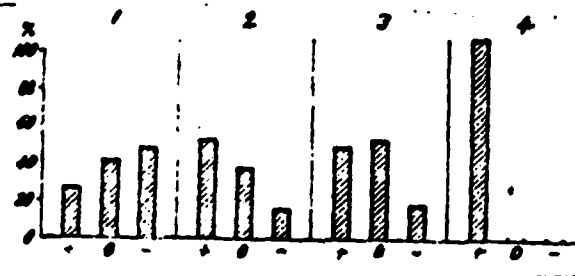


Fig. 2. Distribution of instances of deviation in time of latent period of visual-motorial reaction by values.
1-without noise and vibration irritation; 2-after noise irritation; 3-after vibration irritation; 4-after combined noise/vibration irritation.

The combined effect of noise and general vibration is accompanied by extension in diastolic phase of the heart by 0.03 - 0.07 sec. with a tendency in many instances toward intensification and subsequent restoration of initial data within 5 minutes. At such an increase in diastolic time the pulse frequency in the given ECG equals 60 beats per minute (decrease by 3-5 beats). This difference constitutes the magnitude of speeding up the pulse as result of combined action of general vibration and noise with parameters, not exceeding standard levels. The systolic index drops here by 3%.

These deviations characterize a much higher degree of simultaneous action of the named factors, in spite of the fact that the magnitude of deviations is within limits of normal physiological reaction of the myocarditis to similar irritations. The height and form of the projection T remained unchanged in all variants of noise-vibration effect, adopted in the investigation.

And so, the investigation carried out by us on the combined effect of medium

frequency noise with an intensity of 85 db and general vibration with a frequency of 50 c and amplitude of 15μ revealed a certain displacement in the physiological reactions of the organism - rise in threshold of audibility, extension in time of latent period of motorial reaction, increase in period of heart systoles (contraction) on account of the diastole's cycle and as result of this a quickening of the pulse at normal initial frequency.

But the displacement of physiological reactions in the given case does not go beyond the limits of normal organismal adaptation, it appears unstable and within a period of 3 minutes in a majority of the observed comes back total restoration of initial state of the investigated functions. The value of a longer lasting combined irritation should be sought in clinical investigation of the effect of general vibration and noise on persons working under industrial conditions with permissible parameters of these factors. In this respect are of interest the investigations by G.L.Navyazhskiy (1940) and V.G.Yermolayev (1941), which have established that durable noise, resulting in a displacement in audibility thresholds within limits of 10 db with restoration within 3 min, appears to be harmless. Our findings are analogous to the findings by these authors.

Conclusions

1. Individual effect of noise of medium frequency spectrum with an intensity of 85 db and general vibration of a frequency of 50 c and amplitude of 15μ causes no expressed displacement in physiological reactions.
2. Combined effect of these factors of very small parameters intensify the physiological displacement of the investigated functions, but this displacement does not go beyond the limits of normal organismal adaptation.

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